

SOME NEW SPECIES  
OF  
ECTOPARASITIC TREMATODES

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INTRODUCTION.

The Director of the New York Aquarium has been good enough during the past two or three years to place at my disposal numerous exotic and other fishes which have died there. I greatly appreciate the privilege, for it gives me the opportunity to secure biological specimens which I could not obtain otherwise.\*

Among these there have been found many forms of parasites of new species and even genera, which it has been thought should be published, and, with that object in view, in the following paper five new species and one new genus are submitted. The form from *Sarda sarda*, *Atalostrophion* is a particularly interesting trematode.

When one considers that these worms are always parasitic and that in many instances the death of their host depends upon the numbers which cause the infestation, it becomes interesting to know how they are propagated. This fact also makes the study of their anatomy more interesting since almost all of them are hermaphroditic. They are supplied with two complete sets of generative organs and when these are thoroughly described there is but little left to say about the worm's anatomy, since they form the main portion of its body. Although their habits

\*Dr. MacCallum has kindly autopsied and reported upon the cause of death of large numbers of fishes from the Aquarium during the past few years, only a few of which are mentioned in this paper. The importance of such studies in fisheries work is very great, and an aquarium offers special advantages for this work on account of the greater opportunity for infection and the protection afforded diseased fishes, which, in natural conditions, would be quickly destroyed by their enemies. This paper is properly a contribution from the Biological Laboratory of the New York Aquarium.—C. H. T., *Director of the Aquarium.*

are interesting, where they may be studied, it is not often that an opportunity is afforded to see them alive and pursuing their usual mode of life. This, however, is quite possible in some cases, for instance, where *Microcotyle* infest the gills of certain fish. By exposing the gills they may be seen literally covered with the worms hanging on the gill filaments while they suck the blood from under the delicate mucous membrane. On the gills, too, may be seen the eggs deposited in hundreds and held in position by the tangled filaments which are attached to either end of the egg. As soon as they are hatched they are prepared to fasten themselves on the gills and to take up the reproduction of their kind and to continue the work of their ancestors. The great irritation caused by all this action induces an outflow of thick mucus, covering the gills and preventing the access of the water to their surfaces, so that the fish even may be suffocated. In addition to this they cause great depletion of blood which soon renders the fish exsanguine and causes its death.

Another strange habit with most of these parasitic worms is, that they have a particular locality or habitat where they confine themselves in or on the body. Thus the *Microcotylidae*, *Diplectana* and *Octocotylidae* are found no where else than on the gills, and the former worm is at least the cause of death of ninety per cent of the angel and butterfly fishes in the tanks of the Aquarium. They are probably not so plentiful, and consequently not so fatal to these fish in their natural habitat, the open sea.

### DIPLECTANUM

#### SUB-FAMILY GYRODACTYLIDAE

#### Genus *TETRAONCHUS*

#### Sub-genus *Diplectanum*

Among the ectoparasitic trematodes there are few which while being as small, are yet more interesting than these forms.

They have been classed in the order *Heterocotylea* and included by Van Beneden and Hesse in the family of *Gyrodactylidae*. As far as known now, they are confined to the gills of marine fishes and we have no record of them until 1857, when Wagner was fortunate enough to discover three members of the

family. These he named *Diplectanum aequans*, found on the gills of *Labrax lupus*; *Diplectanum pedatum* on the gills of an unknown fish of the Julis family, and *Diplectanum echeneis* on the gills of *Sargus rondeletii*. However, other than naming them he gave little or no description of the worms by which they might be recognized.

In 1862 Van Beneden and Hesse did the genus more justice, but it was not until 1904 that it was much more completely described by MacLaren, who has endeavored thus to make *D. aequans* the type species.

In 1862 Van Beneden and Hesse described the worm discovered by them as *D. sciaena* from the gills of *Sciaena aquilla*, one of the drumfish.

Parona and Perugia discovered and described a form which they called *D. aculeatum*. We have then thus far five members of this sub-genus described as follows:

*Diplectanum aequans*, Wagener, 1857, Diesing, 1858, MacLaren, 1903; *Diplectanum pedatum* Wagener 1857; *Diplectanum echeneis*, Wagener, 1857; *Diplectanum sciaena*, Beneden and Hesse, 1863 and 1864; *Diplectanum aculeatum*, Parona and Perugia, 1890.

In 1904, when Norman MacLaren wrote very fully upon *D. aequans*, he also summed upon what had been written of the other forms to that date.

*Diplectanum teuthis*, nov. sp.\*

(Fig. 132)

On May 22, 1914, I found *Diplectanum teuthis* on the gills of a *Teuthis hepatus*, a small worm of this species which differs in many particulars from any of those hitherto described, consequently I have ventured to name it *D. teuthis* and to call it a new species. It is only .75 mm. in length by .10 mm. in width. However, its anatomy is fairly distinct so that a reliable description may be given of it.

\*All of the forms described in this paper were found in material from the New York Aquarium.

The body of the worm is elongated, slender and ends posteriorly in a trumpet-shaped disc, which is armed with four strong yellow chitinous hooks of a peculiar shape. There are also in this locality a number of stiff hair-like processes which extend some distance anteriorly from the disc along the posterior end of the body. I wish to draw attention to the shape of these hooks, which are shown in Fig. 134. The hooks in the disc have as their foundation of attachment, two blocks of chitinous material. These are placed, one anteriorly and the other posteriorly in the wall of the hollow disc. They act with a certain amount of motion as if jointed, and thus allow free action of the hooks, which are under the control of the worm.

The head is narrow and unarmed with a notch at the anterior end which marks the situation of the mouth, and on each side of this there are three tactile papillae which stain more highly than the surrounding structure. These areas seem also to furnish some secretion, since small ducts may be seen proceeding backward from them as far as the pharynx. Their function is, as in all of these worms, to afford mucus or saliva to the pharynx and esophagus and to enable them to feel their way about. Anterior to the pharynx are four ocular spots. The pharynx is large relatively and is succeeded by a very short posterior pharyngeal esophagus, since it divides almost at once into the intestinal ceca. On each side of the pharynx and beginning of the intestinal ceca are a number of unicellular glands. A short distance posterior to this angle but also in the center of the body is the genital pore surmounted by a very prominent organ, the chitinous cirrus, which in this species is of the shape of a sickle with the handle.

The *male genital* apparatus consists of a single testis, oval in shape and relatively large. It is situated posterior to the ovary and the vas deferens passes dorsally over the ovary on its way to the large ductus ejaculatorius; this duct gives off a tube which proceeds somewhat backward to enter the bulbus ejaculatorius, being surrounded just before entering that organ by the prostatic gland. The bulbus ejaculatorius is a more or less round organ or muscular bag through which the vas deferens passes to the base of the cirrus. The cirrus is peculiar. Its shape being that of a sickle, including the handle, which latter

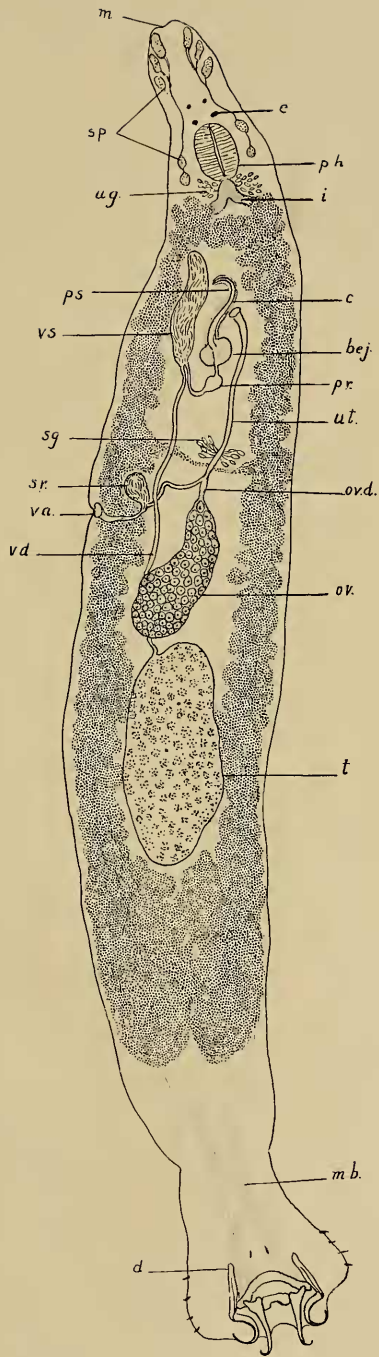


FIG. 132. *DIPLECTANUM TEUTHIS*

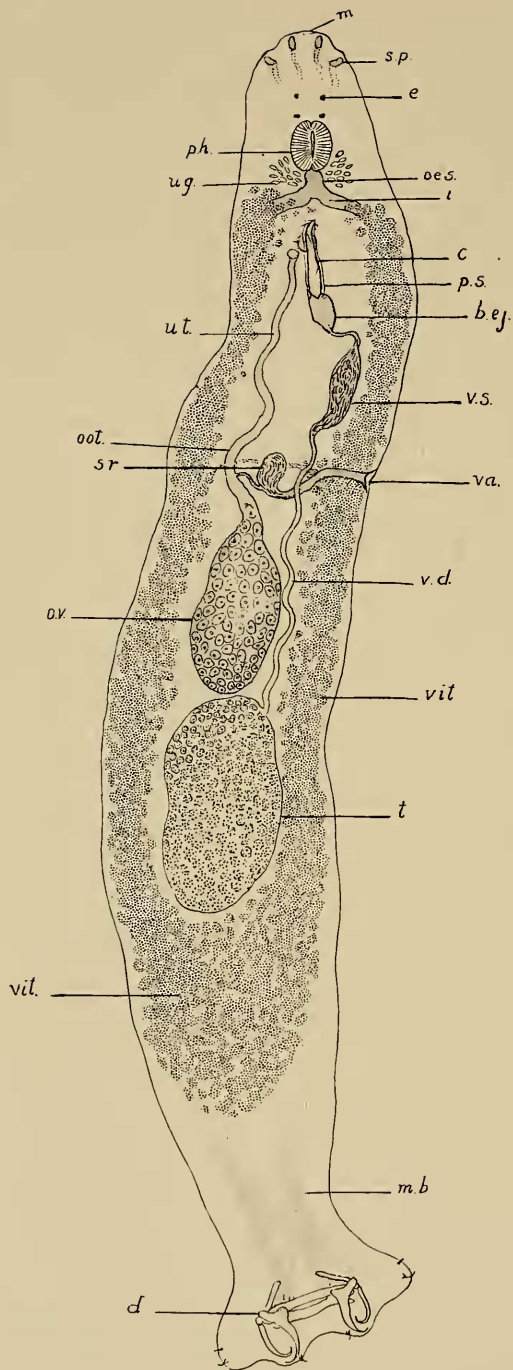
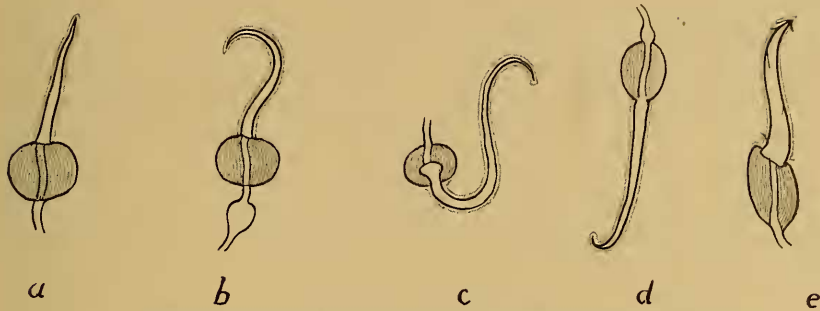


FIG. 133. *DIPLECTANUM LACTOPHRYS*

FIG. 134. CIRRI OF SEVERAL SPECIES OF *DIPLECTANA*

seems to form part of the ejaculatory apparatus. The organ itself is a hollow tube, much bent and composed of yellow chitinous material (Fig. 134b).

The *female genital apparatus* consists of a reniform ovary situated about the middle of the body. The oviduct is short and the genital junction is a short distance anterior to the ovary. On the right side of the worm may be seen the opening of a vagina which joins the seminal reservoir near the genital junction.

The vitellaria are plentiful and extend on each side of the body near the pharynx to a short distance anterior to the disc; small vitelline ducts are sent almost horizontally to the genital junction from each side.

The uterus extends from the ootype near the genital junction to an atrium near the base of and to one side of the cirrus.

Measurements of *Diplectanum teuthis*:

Length .....	.75 mm.
Width .....	.10 mm.
Length of cirrus .....	.04 mm.
Diameter of disc .....	.08 mm.

*Diplectanum lactophrys*, nov. sp.

(Fig. 133)

On February 19, 1915, there were found on the gills of a cow fish, (*Lactophrys tricornis*), a colony of small *Diplectana*

which owing to a few characteristics not possessed by other members of this family, must necessarily make it constitute a new species. It is small, being only 1 mm. in length by .10 mm. in width; it has, however, the usual general conformation of the genus.

Its body is elongated and narrow and of almost an equal width throughout, except at the posterior end where the hook disc is somewhat wider. The disc is, however, quite different from any of the forms hitherto described; it is more footlike in shape,—in fact, in some specimens it is quite the shape of a foot, but ordinarily it extends equally on each side of the end of the body. This shape is caused largely by there being on each side a prolongation of skin, which is armed with two small hooks. Then on each side of the notch in the centre of the distal margin there is fixed another small hook. In the centre of the disc towards its margin are two small blocks of yellow chitinous tissue, which give attachment to the bases of the main hooks of the disc, of which there are, as usual, four—two attached to the block placed in the anterior wall of the disc and two attached to the posterior block.

These blocks are of a peculiar shape and differ in each species (Fig. 133). The blocks are each separated into parts which like joints allow of the motion of the hooks at the will of the worm. As will be seen also if observed closely, the hooks are not of the same shape as those of other members of the genus. In the posterior region may be seen the muscular bands which extend from the disc up into the body and which control the movements of the disc with its hooks. Some bands, if not the chief ones, are seen to pass from one side of the disc to the opposite side of the body. This is probably for the more varied adjustment of the hook disc.

The head in its general conformation and the organs of the body generally are much the same as in the description given of the type except in the cases of the cirrus which is quite different and will constitute one decided point in the diagnosis of the species.

The *male genitalia* are the single large roundish testicle, which lies posterior to the ovary in the center of the body. It gives off from its anterior part the vas deferens which runs



along the left side of the abdomen to empty into a rather large irregularly shaped vesicular seminalis situated opposite the base of the cirrus. This reservoir furnishes a small tube which enters the bulbus ejaculatorius and passes to the pointed base of the cirrus which points to and sometimes overlies the genital pore. The cirrus here is long and straight except near the tip where it becomes curved and pointed. At its base it is provided with an oval bulbus ejaculatorius quite elongated while in nearly all of the other species this is round or nearly so. The base, too, of the cirrus is pointed where the tube or vas deferens joins it; it then shortly widens until it suddenly narrows to the portion outside of the bulbus ejaculatorius. The cirrus proper, however, is of firm chitinous tissue which cannot alter in shape even during conjugation, so that as it is quite prominent it shows a good index of the species (Fig 134e). The cirrus is enclosed in a sort of shell or outer cover and in this instance the penis seems to be armed near the tip with fine spicules, and there appear a few of these spicules also near the base. It is barely possible that this condition may be owing to faulty refraction, still as almost all of the specimens show the same it probably is true.

The *female genitalia*, as usual, consist of an ovary, oval in shape, becoming pointed anteriorly and from which part arises the oviduct—this is not long before it receives the duct from the seminal reservoir and the vitelline ducts; the ootype follows and merges into the uterus, being surrounded here by the shell gland. The uterus terminates with a somewhat flaring mouth at the genital atrium. The vagina opens at the left side of the body when it is looked at from the ventral side of the body. The *viteliaria* are plentiful, extending on both sides of the body from near the pharynx to near the posterior end and across the body posterior to the testis.

These worms are all ectoparasitic, living on the gills of marine fishes. They are not as a rule found in great numbers, although there may be many more than appears since they cannot be seen in situ on the gills, and they do not wash off readily on account of the firm hold of the hooks. The fish as a rule which are infested with them become thin and flabby, and finally die, probably owing largely to the ravages of the worm when in great numbers.

Measurements of *Diplectanum lactophrys*, n. sp.

Length of body .....	1 mm.
Width of body .....	.10 mm.
Diameter of disc .....	.15 mm.
Length of cirrus .....	.10 mm.

*Diplectanum balistes*, nov. sp.

(Fig. 135)

On January 13, 1913, on the gills of a trigger fish, (*Balistes carolinensis*) were found a few examples of a small worm which on close study proved to be a *Diplectanum* and a new species, inasmuch as it differs from any others of the genus examined. It is but .55 mm. in length by .09 mm. in width. The body is elongated and, unlike many of the other members of the family, it becomes decidedly and abruptly smaller near the discal end and the disc itself is very different from that of the others. Instead of being trumpet-shaped it is merely a straight tube armed with four hooks and about six smaller ones. The large ones measure .02 mm. and the smaller ones .003 mm. The hooks also are different in shape from those of the other forms described (Fig. 135).

The *male genitalia* consist of one testis situated near the middle of the body and just posterior to the ovary. The vas deferens runs dorsal to the ovary in a convoluted form to join a fusiform vesicula seminalis which lies to the left of and slightly posterior to the genital pore. At its anterior end it narrows into a small tube which enters the bulbus ejaculatorius and passes through to enter the cirrus, which in this instance is an almost perfectly straight tube (Fig. 134a) and in the specimen under observation lies pointing anteriorly directly across the genital pore. It is almost .04 mm. in length.

The *female genitalia* consist of the ovary lying, when viewed ventrally, partly on the testis. It is oval and narrows anteriorly into the oviduct, which is almost immediately joined by the duct from the seminal reservoir which receives the vagina from the right side. The genital junction is just anterior to the ovary and the uterus, which is short, terminates at the edge of the genital pore.

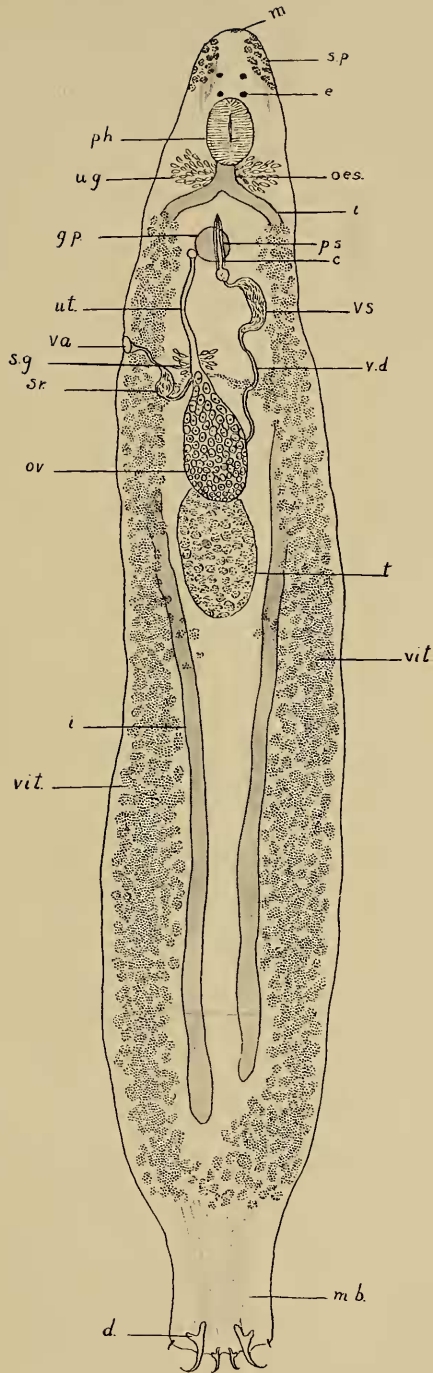


FIG. 135. *DIPLECTANUM BALISTES*

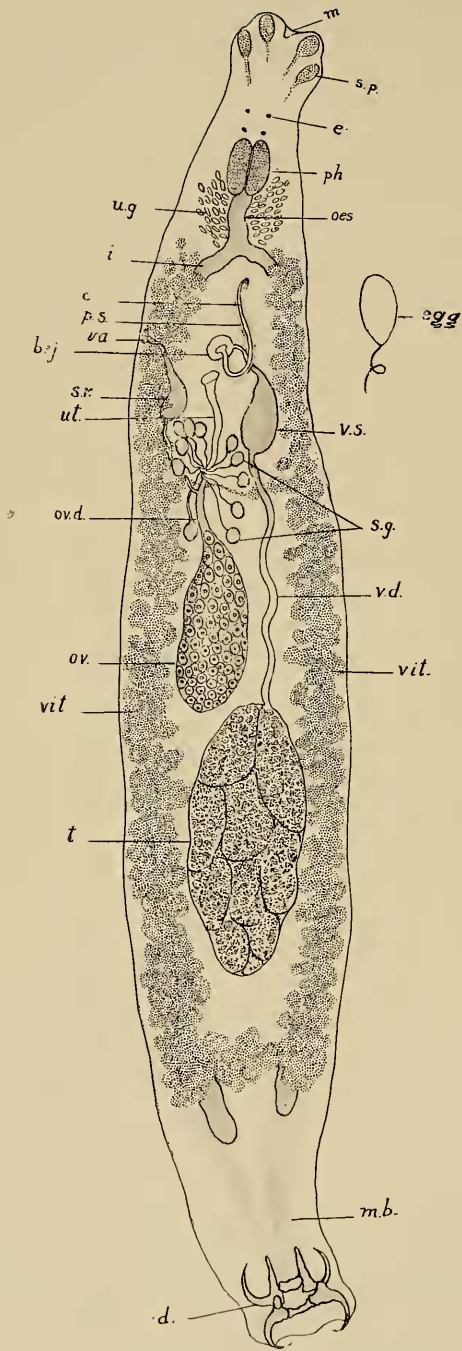


FIG. 136. *DIPLECTANUM LONGIPHALLUS*

The head is formed much like that of others of the family, a slight notch at the extreme tip and on each side a row of papillae extending back almost to the pharynx, which is large. The post-pharyngeal esophagus is short and the angle on each side of the pharynx and esophagus is filled with unicellular mucous glands. Anterior to the pharynx are the usual four ocular spots. The vitellaria are plentiful and extend almost from opposite the genital pore to the point posteriorly where the body suddenly narrows to form the disc. The hooks on the disc have their bases attached to the usual two chitinous blocks of yellow material. These are not of the same shape as in *D. teuthis* or *D. longiphallus*.

For the purpose of description, the characteristics of the worm are, that it is small, has a straight tubular disc end, four large hooks and several small ones clustered in the end of the disc, and the cirrus straight and pointed.

On account of these peculiarities the worm must be considered a new species and the name *D. balistes* is proposed.

Measurements of *Diplectanum balistes*.

Length .....	.55 mm.
Width .....	.09 mm.
Diameter of disc .....	.035 mm.
Width of head .....	.02 mm.
Length of cirrus .....	.04 mm.

*Diplectanum longiphallus*, nov. sp.

(Fig. 136)

On January 23, 1915, there were found on the gills of a spade fish, *Chaetodipterus faber*, a colony of *Diplectana*, which apparently are different from those described heretofore.

In general appearance they are like those found on the surgeon fish, (*Teuthis hepatus*) and in *Balistes Carolinensis*, or trigger fish, but in detail the anatomy is somewhat different. Like them it is small; being only about 1 mm. long by .15 mm. wide. The clinging disc seems in general form the same in almost all, a firm terminal mass with four relatively large, strong hooks attached to odd shaped chitinous blocks, which serve to support the

hooks and increase the firmness of their grasp on the tissues to which they cling. The head is similar, with the usual tactile or sensory papillae on each side, in this instance only two but somewhat larger than in the other forms. An esophagus can be made out between the pharynx and the mouth end and in front of the pharynx are the usual four ocular spots. The pharynx is large and the post-pharyngeal esophagus is longer before the division into ceca than the pre-pharyngeal portion. The genital pore is in the angle between the ceca in the centre of the body and this is surmounted by an oddly shaped chitinous cirrus, quite different from those of the forms above mentioned (Fig. 134c). In this instance it is very long and much bent or curved.

The *male genitalia* are very similar to that usual in the species but with some peculiarities. For instance the testis is single, very large and enclosed in a membranous sac, is divided into large lobes, and is more or less pointed anteriorly. It is situated posteriorly to the ovary and from the anterior end gives off the vas deferens, which passes forward to empty into a large seminal vesicle, placed alongside of the genital aperture on the left side; from this the vas passes into the bulbus ejaculatorius before terminating in the cirrus.

The *female genitalia* consist as usual of the ovary, which is large, oval and pointed anteriorly where it gives off the oviduct. The vagina is not very definite in most of the specimens before me but in most of them the situation of the seminal reservoir is seen and a tube leading to the oviduct is evident. The shell gland in this species is peculiar since it is composed of ten or fifteen large, round, cellular masses that communicate with the ootype by means of long tubes, and give the glands the appearance of being set up on stalks. The vitellaria are very plentiful and the vitelline ducts meet and join the oviduct anterior to the entrance of the duct from the seminal reservoir.

The uterus is not long and terminates with a somewhat flaring mouth near the genital pore near the bulbous end of the cirrus. Several eggs are seen in the eight or nine mounted specimens before me; one in each. These are yellow, oval and with a filament at the posterior pole,—length .02 mm. (Fig. 136.)

For the purpose of classification this form shows the following special characteristics: Shell gland unusually prominent

and composed of ten or fifteen large round glands with very long ducts. Cirrus quite long, a good deal curved and with an oval bulbus ejaculatorius which appears quite muscular. Testis lobulated. These differences from the other species described force me to regard this as a new species for which the name of *Diplectanum longiphallus* is proposed.

Measurements of *Diplectanum longiphallus*.

Length .....	.95 mm.
Width .....	.15 mm.
Length of cirrus .....	.25 mm.
Length of disc .....	.08 mm.
Width of head .....	.05 mm.
Egg .....	.02 mm.

*Atalostrophion sardae*, nov. gen. & nov. sp.

(Figs. 137 and 138)

During the summer of 1912, I first found on the gills of the bonito, (*Sarda sarda*) by washing, a number of fragments of a small, flat, ribbonlike worm. It was always found to be broken at the end, but when stained and mounted it was seen to contain internal organs of a tubular form; that is, there were two, sometimes three tubes containing eggs, which were portions of the uterus. Between these uterine tubes was a brownish tube containing brownish yellow granules—the vitellarium—and besides these could also be seen the tubular testis and a vas deferens containing spermatozoa. No matter how many pieces were examined from the gills, they were always imperfect; both ends being torn across. This was the case during 1912 and 1913, although very few bonitos came to autopsy in the laboratory. However, it was determined in 1914, that an attempt should be made to find out the origin of the pieces and to secure a whole worm if possible. As a result of this determination sixteen bonitos were examined in all and seven of them found to be infested with the worm. It was then discovered that the worm had its habitat not in the gills of the fish, but was found in great numbers under the mucous membrane of the branchial cavity on each side of the isthmus, and also was

found embedded in great numbers in the thyroid glands and throughout the substance of the isthmus itself.

When the muscular layers were carefully parted, the worm was seen flattened in tangled layers. Some of these were seen dangling from the surface in loops, the examinations being made under water, as this was the simplest way to secure a view of the parasites in situ. I have no doubt now that the loops are broken off by the action of the gills and water and become entangled in the meshes of the gills, doubtless for the purpose of distribution in one way, since every fragment is loaded with eggs. It is certain, however, that the local habitat of the worm is in the cellular tissue under the skin and mucous membranes of the branchial cavity and neighboring tissues of the throat, including the space between the muscular fasciculi of the muscular tissues of the isthmus.

It may be said, that a great deal of time has been spent with most careful and assiduous research in the endeavor to find a whole worm. Out of the hundreds traced and teased out only two whole worms have been secured and both of these were immature. Three or four ends, however, have been secured,—heads and tails of adults which are shown in Figs. 137 and 138. It has been concluded that it is next to impossible to tease out an adult worm from the fact that they all seem to be imperfect. One may lift carefully the mucous membrane or a layer of muscular tissue from a tangled mass which certainly has never been disturbed or injured before, and examine the specimens as carefully as possible in situ, and it is almost impossible to see a perfect end; let alone a whole worm. In consequence one must conclude that it is natural for the worm to disseminate its eggs by throwing off the parted sections, as well as by the natural exit from the uterus. The one young specimen secured is 50 mm.—nearly two inches long—and the other more developed one is about 70 mm. in length. Even though dissecting with the greatest care and using a stereoscopic lens, on no occasion have I been able to secure a piece of the body of greater length than 75 mm. This is not to be wondered at when it is known that the worm is only about .60 of a mm. wide; not more than as thick as tissue paper. Its structure, too, seems to be very delicate; breaking at the slightest touch, almost. The skin is smooth and unarmed. It is difficult to state the length of an